

Application No. 10/007,288
Amendment dated August 6, 2003
Reply to office action of May 8, 2003

REMARKS/ARGUMENTS

The preceding amendments and following remarks are submitted in response to the Office Action of the Examiner mailed May 8, 2003. Claims 1-65 are pending, with claims 56-65 being newly presented. Entry of this amendment and reconsideration by the Examiner to that end is respectfully requested.

On pages 2-3 of the Office Action, the Examiner objected to the drawings under 37 C.F.R. 1.83(a) as not showing each and every feature of the invention as specified in the claims. The Examiner states that the "bond pads", and the extent to which the bond pads are "in registration" with the bond-pad holes, must be shown or the feature(s) canceled from the claim(s).

After careful review, Applicants must respectfully disagree that the drawings do not show each and every feature of the invention as specified in the claims, and more specifically, "bond pads" that are in registration with bond-pad holes. For example, Figure 6A-6C clearly show a "bond pad" 33 in registration with a bond pad hole 35. Figure 6A is reproduced below, with a bond pad 33 encircled with a dotted line.

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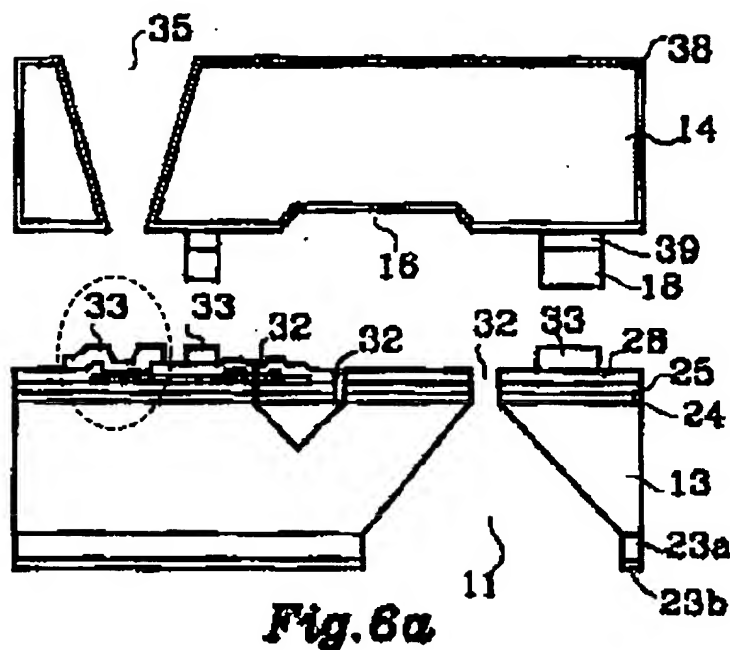


Fig. 6a

In the embodiment shown in Figure 6A, the bond pad 33 is positioned on a first wafer (e.g. wafer 13), and the bond pad through-hole 35 extends through a second wafer (e.g. wafer 14), wherein the bond pad 33 is aligned ("in registration") with the bond pad through-hole 35. In addition, the present specification states:

Five hundred angstroms of Cr, 2000 angstroms of Ni and 5000 angstroms of Au are deposited, patterned and lifted off for pad and solder frame metal 33 in FIG. 4j. Passivated leadouts 40 in first metal 26 or second metal 27 pass under the seal ring metal 33 in FIG. 4j.

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(Emphasis Added)(Specification, column 3, lines 1-4). As can be seen, and in the illustrative embodiment, the same patterned metal layer 33 forms both the solder frame and the bond pad, and thus both are labeled layer 33. As the Examiner notes, the present specification also states:

Wafer 14 has a solder adhesion metal and solder ring 15 which matches detector wafer 13, a border 18 forming chamber 16 above detectors 17, and holes 35 through wafer 14 to access the wire bond pads on detector wafer 13.

(Emphasis Added) (Specification, column 3, lines 18-22). When this is read in view of, for example, Figure 6A shown above, it is clear that the present specification discloses a bond pad 33 that is "in registration" with a bond pad through-hole 35. In fact, the present specification clearly discloses that the bond pad through-hole 35 provides access (e.g. physical access) to wire bond pad 33 on the detector wafer 13. Also, Figure 6A, as well as other Figures, clearly shows a wire bond pad 33 on the first side of the first wafer (the inner side of wafer 13 which defines the formed chamber). In view of the foregoing, Applicants believe that the drawings clearly show each and every feature of the invention as specified in the claims, and more specifically "bond pads" that are "in registration" with the bond pad through-holes, as well as bond pads on the first side (e.g. inner side) of a first wafer. If the Examiner disagrees with the foregoing, the undersigned respectfully requests an interview with the Examiner to better understand the Examiner's rejection.

On page 3 of the Office Action, the Examiner rejected claims 49 and 55 under 35 U.S.C. § 112, first paragraph, because the specification does not reasonably provide enablement for the bond pads to be in registration with the bond pad holes or for the bond pads to be disposed on the

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first wafer's first side. As detailed above, Applicants believe that the present specification clearly discloses a bond pad 33 that is "in registration" with a bond pad through-hole 35. In fact, the present specification clearly discloses that the bond pad through-hole 35 provides access (e.g. physical access) to wire bond pad 33 on the detector wafer 13 (see Figure 6A, for example). Also, Figure 6A, as well as other Figures, clearly shows a wire bond pad 33 on the first side of the first wafer (the inner side of wafer 13 which defines the formed chamber). In view of the foregoing, Applicants must respectfully traverse the 35 U.S.C. § 112, first paragraph, rejection of claims 49 and 55.

Despite the foregoing, Applicants have amended claim 49 and 55 to remove the term "registration". Claim 49 now recites that the first wafer and second wafer are aligned so that the bond-pad holes in the second wafer provide physical access to the one or more bond pads on the first wafer through at least selected bond-pad holes in the second wafer. The term physical access is used to distinguish it from mere electrical access. On page 5 of the Office Action, the Examiner appears to be suggesting Harris et al suggests electrical access.

On page 4 of the Office Action, the Examiner rejected claims 44-55 under 35 U.S.C. § 102(e) as being anticipated by Harris et al. (U.S. Patent No. 5,865,417). The Examiner states that Harris suggest a first silicon wafer (20) and a second silicon wafer (22) defining a chamber or sealed cavity (10), wherein the first and second wafer have a sealing ring (87, 89) therebetween. The Examiner further states the first wafer has a pump-out port (12) which is

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subsequently plugged by a seal (26) (citing Harris et al., column 6, lines 4-6, 11-19; column 10, lines 17-21; and column 11 line 18 et seq.)

Claim 44 has been amended as follows:

44. (Presently Amended) A method for making a wafer-pair with a sealed chamber therebetween, comprising:
providing a first wafer and a second wafer;
forming one or more pump-out ports through the first wafer;
positioning a first side of the first wafer next to a first side of the second wafer ~~with a sealing ring therebetween~~, the first wafer and the second wafer ~~and the sealing ring forming at least part of a chamber~~, with the pump-out port of the first wafer in fluid communication with the chamber; and
exposing the chamber to a negative pressure relative to atmosphere while plugging the pump out port to seal the chamber.

As can be seen, claim 44 has also been amended to recite the step of exposing the chamber to a negative pressure relative to atmosphere while plugging the pump out port to seal the chamber. Nothing in Harris et al. appears to suggest this step. Instead, Harris et al. appear to fill the cavity with a working fluid, where the function of the working fluid 12 is to expand the sealed cavity 10 when the material is heated so as to cause movement in the membrane 14 which is sufficient to move a valve member 44 enough to open a valve (Harris et al., column 3, line 63 through column 4, line 2). When sealing the cavity, Harris et al. state:

The eutectic bond is formed by placing a 25 micron thick gold-tin alloy perform washer 154 between the underside of the silicon fill cap 26 and the top metallization layer 130 surrounding the fill hole. The silicon fill cap is then placed over the fill hole, and a reflow head is then placed cold on the fill cap. A pulse of energy is then supplied to heat the reflow head, the silicon chip 26 and the metallization layers to about 350 degrees centigrade. The gold-tin perform washer then melts and the gold therein forms a gold solder with the melted gold of the facing gold layers on the underside of the silicon chip 26 and the metallization layer 130.

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(Harris et al., column 13, lines 48-59). As can be seen, nothing here suggests the step of exposing the chamber to a negative pressure relative to atmosphere while plugging the pump out port to seal the chamber, as recited in claim 44. Claim 44 has also been amended to remove the sealing ring limitation, as it is not believed to be necessary. For these and other reasons, independent claim 44 and dependent claims 45-47 are believed to be clearly patentable over Harris et al.

Independent claim 48 has been amended to recite:

48. (Presently Amended) A method for making a wafer-pair with a sealed chamber therebetween, comprising:
providing a first wafer and a second wafer;
forming one or more pump-out ports through the first wafer;
making a recess in a first side of the first wafer and/or a first side of the second wafer;
positioning the first side of the first wafer next to the first side of the second wafer, the first wafer and the second wafer forming a chamber that is at least partially defined by the recess, with the pump-out port of the first wafer in fluid communication with the chamber; and
exposing the chamber to a negative pressure relative to atmosphere while plugging the pump out port to seal the chamber.

For similar reasons to those given above with respect to claim 44, claim 48 is also believed to be clearly patentable over Harris et al.

Independent claim 49 has been amended to recite:

49. (Presently Amended) A method for making a wafer-pair with a sealed chamber therebetween, comprising:
providing a first wafer having a first side, with one or more bond pads on the first side;
providing a second wafer;
forming one or more bond-pad holes through the second wafer;

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positioning the first side of the first wafer next to a first side of the second wafer ~~with a sealing ring therebetween; the first wafer and the second wafer and the sealing ring forming at least part of a chamber, the first wafer and second wafer being aligned so that the bond-pad holes in the second wafer are in registration with~~ provide physical access to the one or more bond pads on the first wafer through at least selected bond-pad holes in the second wafer; and the first and second wafers are effectively a bonded together set of wafers.

As can be seen, and as noted above, claim 49 has been amended to recite that the bond-pad holes in the second wafer provide physical access to the one or more bond pads on the first wafer, rather than merely electrical access. Nothing in Harris et al. appears to provide bond-pad holes in a second wafer that provide physical access to the one or more bond pads on a first wafer. For these and other reasons, independent claim 49 is believed to be clearly patentable over Harris et al.

Independent claim 50 has been amended to recite:

50. (Presently Amended) A bonded wafer pair, comprising:
a first wafer;
a second wafer;
the first wafer having one or more pump-out ports through the first wafer;
the first side of the first wafer bonded to a first side of the second wafer via a sealing ring; the first wafer, the second wafer and the sealing ring forming a chamber, with the pump-out port of the first wafer in fluid communication with the chamber, the chamber having a negative pressure therein relative to atmosphere; and
a plug for plugging the pump out port.

As can be seen, claim 50 recites that the chamber has a negative pressure therein relative to atmosphere. For similar reasons to those given above with respect to claim 44, as well as other

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reasons, independent claim 50 and dependent claims 51-53 are also believed to be clearly patentable over Harris et al.

Independent claim 54 has been amended to recite:

54. (Presently Amended) A bonded wafer pair having a sealed chamber, comprising:
a first wafer;
a second wafer bonded to the first wafer;
one or more pump-out ports through the first wafer;
a recess in a first side of the first wafer and/or a first side of the second wafer;
the first wafer and the second wafer forming a chamber that includes the recess, with the pump-out port of the first wafer in fluid communication with the chamber, the chamber having a negative pressure therein relative to atmosphere;
and
one or more plugs for plugging the one or more pump out ports to seal the chamber.

As can be seen, claim 54 recites that the chamber has a negative pressure therein relative to atmosphere. Thus, for similar reasons to those given above with respect to claim 44, as well as other reasons, independent claim 54 is believed to be clearly patentable over Harris et al.

Independent claim 55 has been amended to recite:

55. (Presently Amended) A bonded wafer pair, comprising:
a first wafer having a first side, with one or more bond pads on the first side;
a second wafer, with one or more bond-pad holes through the second wafer;
the first side of the first wafer bonded to a first side of the second wafer with a sealing ring therebetween, the first wafer and second wafer being aligned so that the bond-pad holes in the second wafer are in registration with provide physical access to the one or more bond pads on the first wafer through at least selected bond-pad holes in the second wafer; and
the first wafer, the second wafer and the sealing ring forming a chamber.

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As can be seen, and as indicated above, claim 55 has been amended to recite that the bond-pad holes in the second wafer provide physical access to the one or more bond pads on the first wafer, rather than merely electrical access. As noted above, nothing in Harris et al. appears to provide bond-pad holes in a second wafer that provide physical access to the one or more bond pads on a first wafer. For these and other reasons, independent claim 55 is believed to be clearly patentable over Harris et al.

Newly presented claim 56 is dependent from claim 44, and further recites a sealing ring positioned between the first side of the first wafer and the first side of the second wafer, wherein the first wafer, the second wafer and the sealing ring form the chamber. For the same reasons given above with respect to claim 44, as well as other reasons, dependent claim 56 is believed to be clearly patentable over Harris et al.

Newly presented claim 57 is indirectly dependent from claim 44, and further recites that the one or more devices include an array of infrared detectors. For the same reasons given above with respect to claim 44, as well as other reasons, dependent claim 57 is believed to be clearly patentable over Harris et al.

Newly presented claim 58 is indirectly dependent from claim 50, and further recites that the one or more devices include an array of infrared detectors. For the same reasons given above with respect to claim 50, as well as other reasons, dependent claim 58 is believed to be clearly patentable over Harris et al.

Newly presented independent claim 59 recites:

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59. (Newly Presented) A method for making a wafer-pair with a sealed chamber therebetween, comprising:
providing a first wafer and a second wafer, the first wafer having a first side and a second side;
forming one or more pump-out ports through the first wafer;
positioning the first side of the first wafer next to a first side of the second wafer, the first wafer and the second wafer forming at least part of a chamber, with the pump-out port of the first wafer in fluid communication with the chamber; and
providing one or more layer(s) by deposition to a second side of the first wafer, wherein the one or more deposited layer(s) plug the pump out port and seal the chamber.

As can be seen, newly presented claim 59 recites the step of providing one or more layer(s) by deposition to a second side of the first wafer, wherein the one or more deposited layer(s) plug the pump out port and seal the chamber. As detailed above, and to seal the cavity, Harris et al. state:

The eutectic bond is formed by placing a 25 micron thick gold-tin alloy perform washer 154 between the underside of the silicon fill cap 26 and the top metallization layer 130 surrounding the fill hole. The silicon fill cap is then placed over the fill hole, and a reflow head is then placed cold on the fill cap. A pulse of energy is then supplied to heat the reflow head, the silicon chip 26 and the metallization layers to about 350 degrees centigrade. The gold-tin perform washer then melts and the gold therein forms a gold solder with the melted gold of the facing gold layers on the underside of the silicon chip 26 and the metallization layer 130.

(Harris et al., column 13, lines 48-59). In view thereof, newly presented claim 59 is believed to be clearly patentable over Harris et al.

Newly presented claim 60 is dependent from newly presented claim 59, and further recites that the one or more layer(s) are deposited by evaporation. Newly presented claim 61 is also dependent from newly presented claim 59, and further recites that the one or more layer(s) are deposited by sputtering. As noted above, Harris et al. does not appear to suggest depositing

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one or more layer(s) to plug the pump out port and seal the chamber, and more specifically, depositing one or more layer(s) by evaporation or sputtering. For these and other reasons, dependent claims 60-62 are believed to be clearly patentable over Harris et al.

Newly presented claim 63 is dependent from independent claim 59, and further recites that the one or more layer(s) are deposited in a negative pressure relative to atmosphere. Newly presented claim 64 is dependent from claim 63, and further recites that the one or more layer(s) are deposited in a high vacuum environment. For the same reasons given above with respect to claims 44 and 59, as well as other reasons, dependent claims 63 and 64 are also believed to be clearly patentable over Harris et al.

Newly presented independent claim 65 recites:

65. (Newly Presented) An apparatus having a sealed chamber with one or more devices positioned in the sealed chamber, the one or more devices having a desired operating temperature range, the bonded wafer pair comprising:
a first wafer;
a second wafer secured relative to the first wafer;
the first wafer and the second wafer forming a chamber that has a volume, wherein the one or more devices are positioned in the chamber;
one or more pump-out ports through the first wafer, at least one of the one or more pump-out ports in fluid communication with the chamber;
one or more plugs for plugging the one or more pump out ports to seal the chamber; and
the volume of the chamber remaining relatively constant over the desired operating temperature range of the one or more devices.

As can be seen, newly presented claim 65 recites that the volume of the chamber remains relatively constant over the desired operating temperature range of the one or more devices. In contrast, and as indicated above, Harris et al. suggest filling the cavity with a working fluid,

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where the function of the working fluid 12 is to expand the sealed cavity 10 when the material is heated so as to cause movement in the membrane 14 which is sufficient to move a valve member 44 enough to open a valve (Harris et al., column 3, line 63 through column 4, line 2). As such, if the volume of the sealed cavity 10 of Harris et al. remained relatively constant over the desired operating temperature of the one or more devices, Harris et al. would fail to function for its intended purpose. As noted the Federal Circuit, if a proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984). For these and other reasons, newly presented independent claim 65 is believed to be clearly patentable over Harris et al.

On page 5 of the Office Action, the Examiner indicated that claims 1-43 are in condition for allowance.

On page 6 of the Office Action, the Examiner states that U.S. Patent No. 5,420,419 and U.S. Patent No. 5,581,631 have not been considered by the Examiner because these references appear to be incorrectly cited. After reviewing the FORM-1449, Applicants believe U.S. Patent No. 5,420,419 was correctly cited, and should be considered by the Examiner. However, with respect to U.S. Patent No. 5,581,631, it appears two numbers were transposed on the FORM-1449, and U.S. Patent No. 5,851,631 should have been cited. Enclosed herewith is a corrected copy of the FORM-1449 previously filed, with the transposed numbers corrected. In addition, a copy of U.S. Patent No. 5,851,631 to Bordon et al. has been attached for the Examiner's

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convenience. Please note that U.S. Patent No. 5,851,631 to Bordon et al. was cited in U.S. Patent No. 6,036,872 to Wood et al., of which this Application is a reissue. In view of the foregoing, Applicants respectfully request that the Examiner please consider U.S. Patent No. 5,420,419 and U.S. Patent No. 5,851,631, and forward an initialed copy of the corrected FORM-1449 to Applicants in due course.

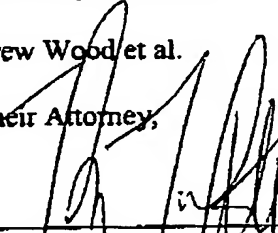
In view of the foregoing, all pending claims 1-65 are believed to be in condition for allowance. Entry of the present amendment and reconsideration to that end is respectfully requested. If a telephone conference might be of assistance, please contact the undersigned attorney at (612) 677-9050.

Respectfully submitted,

Andrew Wood et al.

By their Attorney,

Dated: August 6, 2003



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FORM PTO-1449 <u>AMENDED AS PER EXAMINER INSTRUCTION</u>	Atty. Docket No.: 1100.1138101 (H16-17400)	Serial No.: 10/007,288
LIST OF PATENTS AND PUBLICATIONS FOR APPLICANT'S INFORMATION DISCLOSURE STATEMENT	Applicant: Wood et al.	
	Filing Date: December 3, 2001	Group Art: 1745

U.S. PATENT DOCUMENTS

Examiner Initial	Document No.	Date	Name	Class	Sub Class	Filing Date If Appropriate
	3,577,037	5/1971	Di Pietro			
	3,973,146	8/1976	Arnold et al.			
	4,400,870	8/1983	Islam			
	4,122,479	10/1978	Sugawara et al.			
	4,369,458	1/1983	Thomas et al.			
	4,555,720	11/1985	Redhead			
	4,582,210	4/1986	Morimoto et al.			
	4,701,424	10/1987	Mikkor			
	4,766,316	8/1988	Jungkman			
	4,784,970	11/1988	Solomon			
	4,821,997	4/1989	Zdeblick			
	4,833,102	5/1989	Byrne et al.s			
	4,897,508	1/1990	Mahulikar et al.			
	5,006,711	4/1991	Hanashima et al.			
	5,021,663	1/1997	Hornbeck			
	5,220,838	6/1993	Fung et al.			
	5,264,693	11/1993	Shimabukuro et al.			
	5,318,666	6/1994	Eklind et al.			
	5,366,587	11/1994	Ueda et al.			
	5,397,897	3/1995	Komatsu et al.			
	5,420,419	5/1995	Wood			
	5,521,123	5/1996	Komatsu et al.			
	5,528,452	6/1996	Ko			
	5,581,631	12/1996	Borden et al.			
	5,585,311	12/1996	Ko			

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	LIST OF PATENTS AND PUBLICATIONS FOR APPLICANT'S INFORMATION DISCLOSURE STATEMENT		

Examiner Initial	Document No.	Date	Name	Class	Sub Class	Filing Date If Appropriate
	5,729,019	3/1998	Krafthefer et al.			
	5,736,430	4/1998	Seefeldt et al.			
	5,865,417	2/1999	Harris et al.			
	5,895,233	4/1999	Higashi et al.			
	6,036, 872	3/2000	Wood et al.			
	6,359,333	3/2002	Wood et al.			

FOREIGN PATENT DOCUMENTS

Examiner Initial	Document No.	Date	Country	Translation Yes No
	2121598	12/1983	GB	
	0453372	10/1991	EP	
	0736972	10/1996	EP	

OTHER ART (Including Author, Title, Date, Pertinent Pages, Etc.)

	Barth, Philip W., "Silicon Fusion Bonding for Fabrication of Sensors, Actuators and Microstructures", Sensors and Actuators, A21-A23, (1990) pages 919-926.
	Bauer D. et al., "Design and Fabrication of a Thermal Infrared Emitter", Sensors and Actuators A., vol. 55, No. 1, July 15, 1996, pages 57-63.
	Cabuz, C., et al., "Fabrication and packaging of a resonant infrared sensor integrated in silicon", Sensors and Actuators A, 43, May 1994, pages 92-99.
	Henmi, H., et al., "Vacuum packaging for microsensors by glass-silicon anodic bonding", Sensors and Actuators A, 43, May 1994, pages 243-248.
	Kniffen M.L. et al., "Packaging for Silicon Micromachined Accelerometers", International Journal of Microcircuits and Electronic Packaging, vol. 19, No. 1, January 1, 1996, pages 75-86.
	Ko, Wen Hsiung, et al., "Development of a Miniature Pressure Transducer for Biomedical Applications", IEEE Transactions on Electron Devices, Vol. ED-26, No. 12, December 1979, pages 1896-1905.

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LIST OF PATENTS AND PUBLICATIONS FOR APPLICANT'S INFORMATION DISCLOSURE STATEMENT	Applicant: Wood et al.	
	Filing Date: December 3, 2001	Group Art: 1745

	Mori T. et al., "Vacuum-encapsulated Thermistor bolometer Type Miniature Infrared Sensor". Proceeding of the Workshop on Micro Electro Mehanica Systems (MEM, IOSO, January 25-28, 1994, No. Workshop 7, January 25, 1994, pages 257-262, Institute of Electrical and Electronics Engineers.
	Huang et al., "n-p-n Silicon Lateral Phototransistors for Hybrid Integrated Optical Circuits", IEEE vol. ED-33. No. 4, April 1986, pages 433-441.
	Reichl H., "Packaging and Interconnection of Sensors", Sensors and Actuators A, 25 27 (1991), pages 63-71.
	Senturia Stephen D., et al., "Microsensor Packaging and System Partitioning", Sensors and Actuators, 15 (1988), pages 221-234.
	Tilmans, Harrie A.C., et al., "Micro resonant force gauges", Sensors and Actuator A. 30 (1992) pages 35-53.
	Wolffenbuttel R.F., et al., "Low-temperature silicon wafer-to-wafer bonding using gold at eutectic temperature", Sensors and Actuators A, 43, May 1994, pages 223-229.

EXAMINER:	DATE CONSIDERED:
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EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP 609; draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.